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The taxonomy, biology and distribution of the Australian jewel beetle *Chrysobothris saundersi* Macleay

(Insecta, Coleoptera, Buprestidae)

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The taxonomy, biology and distribution of the Australian jewel beetle, *Chrysobothris saundersi* Macleay (Coleoptera, Buprestidae, Chrysobothrinae) are described. *Chrysobothris hopei* Obenberger is confirmed as a synonym of *C. saundersi*. The adults of *C. saundersi* are redescribed and the species and its genitalia (both male and female) illustrated for the first time. Relationships with other *Chrysobothris* species are discussed and biological and ecological characteristics outlined. A key to the presently recognised species of *Chrysobothris* occurring in Australia is also provided. *Chrysobothris saundersi* is known to breed in the dead wood of *Acacia leiocalyx* (Domin) Pedley (Mimosaceae) in Queensland and *Casuarina stricta* Dryander (Casuarinaceae) in New South Wales. The larval galleries and pupal chambers are also described and illustrated. The first record of the species from New South Wales is also published.

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Introduction

The genus *Chrysobothris* Eschscholtz (Coleoptera, Buprestidae, Chrysobothrinae), is a very large genus of some 700 species distributed throughout the world, with North America north of Mexico containing about one quarter (25 %) of the world total (Fischer 1942). Australia is very poorly represented in terms of species of this genus; Carter (1925), who provided the last account of the Australian *Chrysobothris*, recognised only nine species. Obenberger (1923) described three new Australian species, namely *C. blackburni*, *C. carteri* and *C. hopei*, all of which Carter (1925, 1929, 1940) later synonymised with previously described species. Undaunted, Obenberger (1928) described a further two new species, namely *C. odewahni* and *C. macleayi*. Although these were both listed in Carter (1929), they were not critically examined and discussed by Carter in any of his subsequent publications on the group, apart from his statement that *C. odewahni* was a synonym of *C. australasiae* Laporte & Gory (Carter 1940) (which is erroneous, Hawkeswood,1983, unpublished data). Another new species, from Townsville, northern Queensland, was described in detail by Hawkeswood (1986a). The latest new *Chrysobothris* , *C. petersoni* T. J. Hawkeswood, has been described very recently from Western Australia, where it had remained unnamed since its initial discovery before the Second World War (Hawkeswood 1995).

The biology of the Australian species is also poorly known (with the exception of *C. queenslandica* T. J. Hawkeswood) and most of the species are poorly represented in museum collections. Adults of

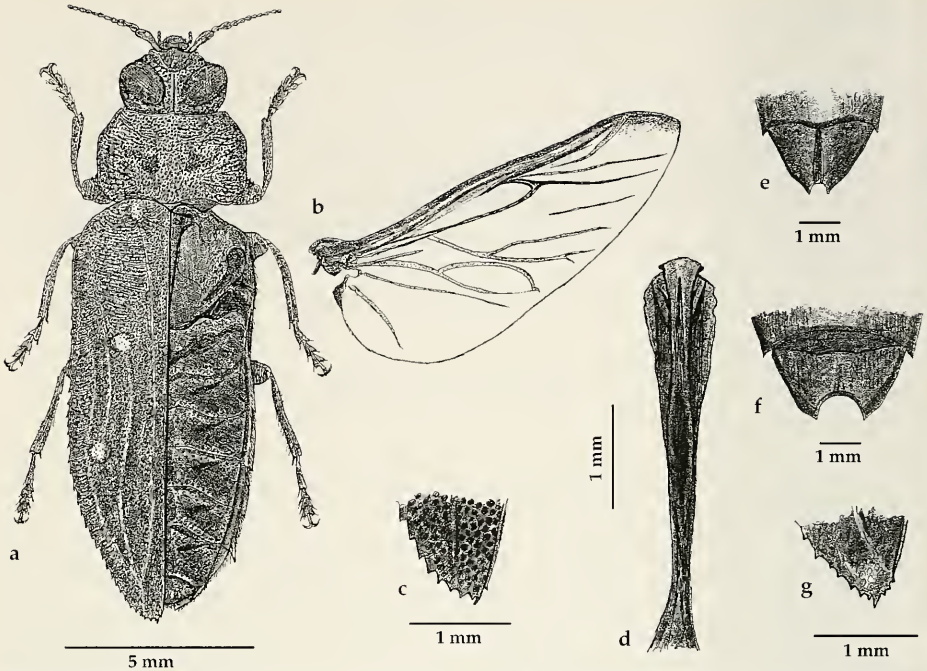

Fig. 1. *Chrysobothris saundersi* Macleay. **a.** Dorsal habitus of ♀ from the Turondale-Hill End area, New South Wales, with right elytron and wing removed to show tergites. **b.** Right wing of ♀. **c.** Apex of left elytron of ♀ showing puncturation. **d.** Ovipositor of ♀. **e.** Underside of abdomen of ♀ showing the prominently carinate keeled last sternite with shallow, narrow notch. **f.** Underside of abdomen of ♂ showing the non-carinate (or weakly impressed) last sternite with wide, deep notch. **g.** Apex of left elytron of ♂ showing puncturation. (Illustration: J. R. Turner).

some species appear to have a strong association with *Acacia* (Mimosaceae) (Carter 1925, 1927, 1932, Hawkeswood & Peterson 1982, Hawkeswood 1986a, 1988). *Chrysobothris queenslandica* is definitely known to breed in *Acacia bidwillii* Benth. (Mimosaceae) at Townsville, north-eastern Queensland (Hawkeswood 1986a), while *C. subsimilis* Thomson has been recorded more recently from *Acacia peuce* F. Muell. (Hawkeswood 1988). The food of the adults of the Australian species have never been recorded. Most of the species occur in arid or semi-arid areas of inland Australia, presumably where large stands of *Acacia* and other suitable hosts occur. The adults of the Australian species of *Chrysobothris* appear to be mostly diurnally active, although Williams (1982) attracted a specimen of an unidentified *Chrysobothris* species to light.

The following abbreviations for insect depositories are used in the following text: AM = Australian Museum, Sydney, New South Wales, Australia; ANIC = Australian National Insect Collection, Canberra, ACT, Australia; GHN = G.H. Nelson private collection, Pomona, California, USA; JH = Jean Harslett private collection, Amiens via Stanthorpe, Queensland, Australia; NMP = National Museum, Prague, Czech Republic; NMV = National Museum of Victoria, Melbourne, Victoria, Australia; QDF = Queensland Department of Forestry Collection, Department of Primary Industries, Indooroopilly, Queensland, Australia; QM = Queensland Museum, Brisbane, Queensland, Australia; SAM = South Australian Museum, Adelaide, South Australia; UQ = University of Queensland collection, Brisbane, Queensland, Australia.

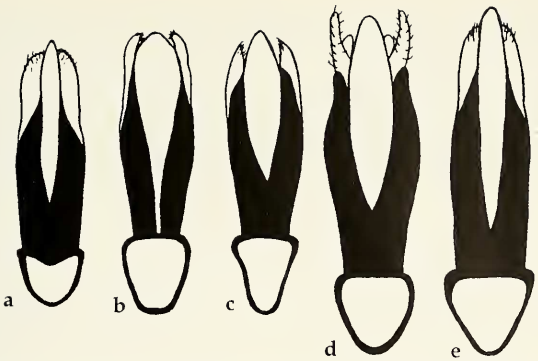

Fig. 2. ♂ genitalia of some Australian *Chrysobothris* species. **a.** *C. peroni* Laporte & Gory. **b.** *C. blackburni* Obenberger. **c.** *C. australasiae* Laporte & Gory. **d.** *C. subsimilis* Thomson. **e.** *C. saundersi* Macleay. (Illustration: T. J. Hawkeswood).

Chrysobothris saundersi Macleay

Chrysobothris saundersi Macleay (Figs 1a-g, 2e, this paper)
Chrysobothris saundersi Macleay, 1872: 246; Carter 1925: 226-227; 1929: 281.
Chrysobothris hopei Obenberger, 1923: 77; Carter 1925: 226; 1929: 281; 1940: 384.
Chrysobotris hopei Obenberger, 1928: 76, 312. (Erroneous spelling).

Type. Holotype: ♂, K32684, Gayndah, Queensland (AM) (Type of *C. saundersi* seen by authors).

Redescription

Male. Moderately elongate and robust, medium-sized, slightly convex; head, antennae, pronotum, scutellum, elytra, legs and undersurface of the body dull metallic bronze-black with copper to bronze reflections; eyes, black; elytra with four, small, median, mostly circular, dull coppery foveate depressions and two smaller or similar-sized, basal, coppery depressions near the anterior margin; mesothorax metallic violet to purple centrally, black elsewhere; tergites metallic coppery-red centrally, black elsewhere, apical tergite purple to violet.

Head coarsely, reticulately, rugose-punctate, moderately clothed with short, anteriorly-directed, silver-white hairs; vertex between the eyes narrow to moderate, about the same width as half the diameter of the eye or wider, with a median, longitudinal, dark, integumental line, not carinate; clypeus narrowly and deeply bisinuate at the anterior margin; frons triangular with two distinct impressions near the vertex; eyes moderately converging behind; antennae: antennomere 1 about 3.0-3.5 times longer than wide, wider at apex; antennomere 2 short, 1.2 times longer than wide; antennomere 3 more slender than antennomere 1, about 3.0 times longer than wide; antennomeres 4-11 progressively smaller, strongly serrate, each with a moderate number of anteriorly-directed, silver-white hairs.

Pronotum about 1.8 times wider than long, widest near the middle and slightly narrower than the width of the elytra; shallowly convex; anterior margin slightly arcuate or straight; posterior margin strongly bisinuate; sides parallel to sub-parallel, slightly arcuately narrowed in front towards anterior margin and behind, towards posterior margin; median line generally indicated by a very shallow depression extending from near base to apex; two, lunate to circular, shallow depressions situated on posterior half towards lateral margins, one opposite each basal fovea on elytra; pronotal disc densely and finely punctate, slightly rugose-striolate in the centre; lateral carina weakly developed, slightly arcuate, not visible from above; pronotum glabrous except for a fringe of short, erect, white hairs on the anterior margin and a few posteriorly-directed hairs on the posterior margin.

Scutellum small, triangular, impunctate.

Elytra slightly wider than pronotum, about 3.5-4.0 times longer than the length of the pronotum; ratio of length at base to length in the midline = 1:2.0-1:2.2 (5 specimens); base of each elytron abruptly rounded; sides parallel behind humeri then broadly, arcuately narrowed to apex; margins prominent and serrate from apex to median, apical serrations extending into suture (Fig. 1g); each elytron with a

small, moderately deep, basal, circular foveate depression at middle, a similar, median, foveate depression in the middle and another post-median foveate depression about ⅔ the distance from the suture to the margin; sutural costa weakly developed, extending from post-median to apex; sutural costa not diverging; elytra without pubescence, densely, finely and evenly punctate.

Undersurface with a moderately dense pubescence of white hairs (especially so on the margins of the abdomen); whole surface densely punctate, becoming less so medianally; proepisternum punctate, moderately pubescent; last abdominal sternite deeply and broadly arcuately incised, non-carinate or with a weak, median impression (Fig. 1f).

Legs with pro-femorae with a well developed obtuse rectangular tooth which is irregularly and feebly denticulate on outer margin; pro-tibiae strongly curved, meso-tibiae straight and meta-tibiae very slightly curved inwards in the upper half; tibiae without teeth but with two sharp spines distally (near tarsi).

Genitalia. Typical of *Chrysobothris* in being straight, with strongly sclerotized, black parameres with membranous lobes bearing outwardly directed setae (Fig. 2e).

Female. Similar to the male and differs in mainly external morphology by having the last abdominal segment carinate and very narrowly incised (Fig. 1e); the female mesothorax is turquoise, emerald green and violet, the tergites (except last) are purple with violet margins and the last tergite is brownish-bronze; there appears to be some difference in the serration of the elytral apex between the sexes (Fig. 1c and 1g), but the consistency of this character has not been examined in any other material apart from that collected from New South Wales; females generally tend to be slightly larger than males, but this is not always the case.

Size (mm). ♂♂: 14.0 ± 1.2 × 5.2 ± 0.5 (13); ♀♀: 14.1 ± 1.9 × 5.3 ± 0.8 (16).

Specimens examined: **Queensland**: 1♂, Paratype K32684, Gayndah, [25°37'S, 151°36'E](no other data)(AM); 1♂, Rockhampton, [23°23'S, 150°31'E], 22 March 1941, E. Sutton and E. Vallis (QM); 2♂♂, Edungalba (via Rockhampton), [c. 23°30'S, 150°20'E], 10 January 1946, E. Adams and E. Sutton (QM); 1♂, Edungalba, January 1964, G.B. (?)(on same card as a ♂ of *Chrysobothris subsimilis* Thomson)(ANIC); 1♂, 1♀, same data (ANIC); 1♂, 2♀♀, Edungalba, E.E. Adams (GHN); 1♀, Milmerran, [27°50'S, 151°20'E], 30 October 1926, J. Macqueen (ANIC); 2♀♀, Milmerran, 11 February 1945, J. Macqueen (JH); 1♀, Milmerran, March 1945, J. Macqueen (NMV); ♀, Milmerran, February 1954, J. M (acqueen)(ANIC); 1♀, Milmerran, J. Macqueen (ANIC); 1♀, Dalby, F.H. Hobler (UQ); 1♂, Dunmore State Forest, via Dalby, 23 December 1980, F.R. Wylie and M. De Baar Acc. 1871-12, on *Acacia leiocalyx* (Domin) Pedley (Mimosaceae)(QDF); 1♀, Warra [near Dalby, 27°11'S, 151°16'E](no other data) (ANIC); 1♀, Fletcher [near Stanthorpe], E. Sutton (QM); 1♂, 1♀, Stanthorpe, [28°29'S, 151°57'E], February 1957, J. Harslett (JH); 2♀♀, "Qld." (no other data)(NMV); 2♀♀ (no collection data)(SAM); 1♀, (no collection data)(UQ). – **South Australia**: 1♂, Beltana, [30°48'S, 138°25'E], 3297 (no other data)(SAM). – **Northern Territory**: 1♂, Harts Range, Central Australia, [23°00'S, 134°56'E], November 1930, T. Hodge-Smith (AM). – **Western Australia**: 1♀, Coolgardie [30°57'S, 121°10'E](no other data)(SAM).

Key to the Australian species of *Chrysobothris*

1. Fronto-clypeus separated from the vertex by a prominent carina; apical sternite of male carinate, deeply and arcuately incised; apical sternite of female carinate, less prominently incised ..... *C. macleayi* Obenberger
– Fronto-clypeus not separated from the vertex by a prominent carina ..... 2.
2. Size large, total body length more than 19 mm long ..... *C. petersoni* T. J. Hawkeswood
– Size smaller, total body length less than 19 mm long ..... 3.
3. Pronotum with large and irregular callosities medianally and on the margins; apical sternite of male non-carinate, shallowly incised; apical sternite of female non-carinate, less prominently incised, sometimes more or less straight ..... *C. caelatus* Carter
– Pronotum without such callosities ..... 4.
4. Pronotum prominently emarginate towards anterior margin; apical sternite of male non-carinate, deeply incised; apical sternite of female non-carinate, shallowly incised ... *C. amplicollis* Thomson
– Pronotum not as above, widest at base or in the middle ..... 5.

5. Pronotum broadly rounded at sides, as wide or slightly wider than width of elytra; apical sternite of male carinate, deeply incised; apical sternite of female carinate or weakly so, less incised ..... *C. australasiae* Hope

– Pronotum slightly rounded to subparallel at sides, narrower than, or rarely equal to, the width of the elytra ..... 6.

6. Underside of body deep metallic green to bronzy-green; elytral spots usually small, golden-green to green; apical sternite of male carinate or weakly so, shallowly to deeply incised; apical sternite of female carinate or weakly so, tri-spinose to almost straight ..... *C. viridis* Macleay

– Underside of body not metallic green ..... 7.

7. Abdominal sternites metallic purple-blue in basal (upper) half to one-third, copper in apical (lower) half to two-thirds; apical sternite of male carinate (or weakly so), deeply incised; apical sternite of female carinate, shallowly incised ..... *C. blackburni* Obenberger

– Abdominal sternites not coloured as above (either multi-coloured, bronze, bronze-black, or copper) ..... 8.

8. Elytral spots small, usually gold or golden-coppery ..... 9.

– Elytral spots large, usually bright coppery-red ..... 11.

9. Underside of body bright copper; apical sternite of male non-carinate, deeply incised, 4-spinose; apical sternite of female carinate, shallowly (but irregularly) incised, 3-spinose ..... *C. queenslandica* T. J. Hawkeswood

– Underside of body multi-coloured, bronze or bronze-black rarely bronze-copper ..... 10.

10. Apical abdominal sternite of male non-carinate, deeply incised, 4-spinose; last abdominal sternite of female carinate, 3-spinose ..... *C. subsimilis* Thomson

– Apical abdominal sternite of male non-carinate, shallowly incised, 2-spinose; last abdominal sternite of female carinate, deeply incised, 2-spinose ..... *C. saundersi* Macleay

11. Pronotum broadly arcuately narrowed towards anterior margin; apical sternite of both sexes carinate, that of the male usually more deeply incised than that of the female ..... *C. peroni* Laporte & Gory

– Pronotum subparallel at sides, sharply narrowed near anterior and posterior margins; apical sternite of both sexes non-carinate, male deeply incised, 4-spinose; female shallowly incised, 2-spinose ..... *C. octomaculata* Carter

Recent field observations on biology and host plant

During 5 November 1995, JRT visited an area south of Turondale, New South Wales (c. 33°07'S, 149°36'E), which is located about 20 km east of Hill End, in order to examine a scattered group of 10-metre tall *Casuarina stricta* Dryander (Casuarinaceae) trees growing near the top of a north-facing hillside. Several species of *Astraeus* (Buprestidae) had been collected at this site during December 1984-85 and because of this, the area was revisited. A number of trees were swept with a net without success so some of the *C. stricta* plants which had been blown down by the wind were then examined. A series of exit holes were found on a branch which was broken and hanging limply in a tree and a number of specimens of a new *Melobasis* species were obtained from this timber. Some dead adults were visible at their exit holes and proper dissection of the timber (later cut into billets) resulted in several adults and larvae being obtained. These will be the subject of a separate paper. Examination of the main trunk section of the tree which was lying on the ground, revealed a second type of exit hole scattered randomly along the trunk. Removal of the bark resulted in the discovery of the remains of another dead buprestid situated in a pupal chamber/exit hole. Initial examination suggested a *Torresita* sp., but when compared with named *Torresita* material in the collection of JRT, they were obviously very different. Later comparison with material of *Chrysobothris* and the type specimen of *C. saundersi* housed in the Entomology Department of the Australian Museum, confirmed the species involved as *C. saundersi*.

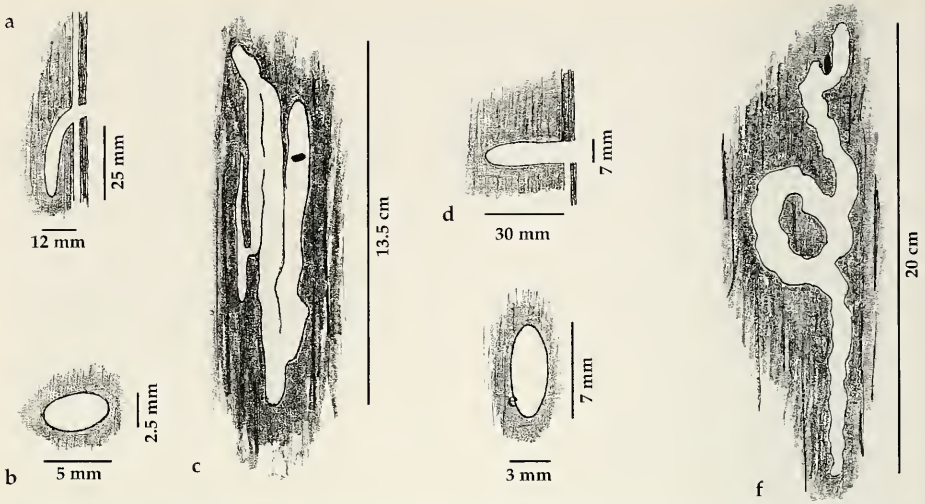

Fig. 3. Larval galleries, pupal chambers and exit holes of *C. saundersi* Macleay in the dead wood of *Casuarina stricta* Dryander (Casuarinaceae) in the Turondale-Hill End area of New South Wales. **a.** Lateral view of ♀ pupal chamber below bark and larval gallery. **b.** Exit hole of ♀. **c.** Larval gallery of ♀ showing position of exit hole with long axis perpendicular to grain of wood. **d.** Lateral view of ♂ pupal chamber below bark and at end of larval gallery. **e.** Exit hole of ♂. **f.** Larval gallery of ♂ showing position of exit hole parallel with grain of wood. (Illustration: J. R. Turner).

On 29 December 1995, during a visit to the same site in order to search for more plant and insect material, the discovery of a second *C. saundersi* specimen (a female) was recorded on videotape. During dissection of some billets of *C. stricta*, two additional specimens (males) were found dead in their pupal chambers.

Both male and female *Chrysobothris saundersi* form larval galleries between the bark and the sapwood (Figs 3a,c,3d,f), but their pupal chambers and exit holes are rather distinctive (Figs 3a,b, 3e,f). The female pupal chamber (Fig. 3a) is almost identical to that of *Agrilus australasiae* Laporte & Gory in shape (Turner & Hawkeswood 1996a, 1997), but is much larger and it slopes downwards into the sapwood; the adult beetle emerges from the chamber with the underside of body and feet facing downwards. The exit holes of the females slope at an angle of about 20 degrees either to the right or left in relation to the latitudinal axis of the branch/trunk (Figs 3b,c). The male pupal chamber enters the sapwood at 90 degrees to the longitudinal axis of the branch/trunk (Fig. 3d) and the exit hole (Fig. 3e) is narrow and vertical (long axis parallel with longitudinal axis of wood) and the adult beetle emerges sideways (90 degrees to vertical). The ratio of male to female exit holes was approx. 10:1 at this site, with those of the females located higher up in the thinner branches.

Discussion

Taxonomy and relationships with other *Chrysobothris* species

Carter (1925: 226) synonymised *C. hopei* Obenberger with *C. saundersi* Macleay but it is obvious that he did not see Obenberger's type specimen. Dr Svatopluk Bílý of the Czech Republic has sent the senior author a coloured photograph and notes on the holotype (female) of *C. hopei* housed in the National Museum of Prague. The specimen is labelled "Rockhampton, Queensland, Meek, No. 23209". Comparison of Obenberger's adequate description of this *Chrysobothris* (Obenberger, 1923: 77)(which mentions the morphology of the last abdominal sternite in detail), with the photograph of the type, leaves us with no doubt as to the synonymy, despite the protestations of Obenberger (1928) who fiercely defended his *C. hopei* as a separate, distinct species. Carter (1940: 384) further promoted his earlier synonymy of *C. hopei* with *C. saundersi*.

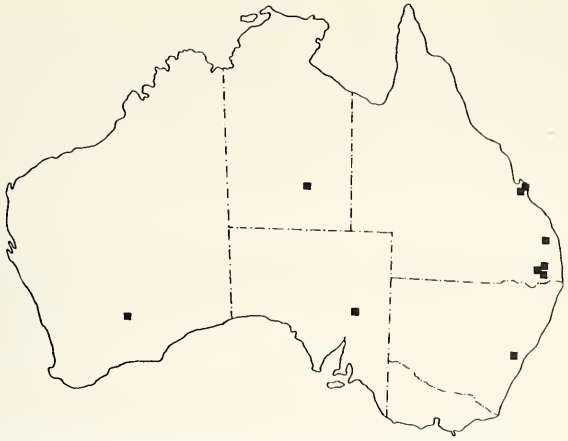

Fig. 4. Distribution of *Chrysobothris saundersi* Macleay. (Illustration: T. J. Hawkeswood).

Carter (1925: 227) erroneously stated that the apical abdominal segments of *C. saundersi* were carinate in both sexes which led him to wrongly key the species (Carter, 1925: 229). It is possible that some of this confusion could have arisen as a result of the similarity between *C. saundersi* and *C. subsimilis* Thomson (a closely related species which also has the last sternite of the male non-carinate and that of the female carinate). Carter may have mixed females of *C. subsimilis* with females of *C. saundersi*. Also, in some males of *C. saundersi*, the last abdominal sternite is weakly impressed (Fig. 1f) but when compared with the females, it can be clearly seen that the sternite is not carinated. The clypeus of *C. saundersi* is more deeply and narrowly incised than that of *C. subsimilis*, the impressions on the pronotum are larger, and the costae are generally not as well developed as in most specimens of *C. subsimilis* which we have examined. The last abdominal sternite of the male *C. subsimilis* is bispinose with two teeth at each apex, so that the sternite is really 4-spinose, whereas in *C. saundersi*, there is only one tooth at each apex, meaning the sternite is 2-spinose (Fig. 1f). The female *C. subsimilis* has a trispinose apical sternite, while the female *C. saundersi* has a bispinose one, with the incision usually very narrow and deep (Fig. 1e).

The male genitalia of *C. saundersi* are very similar in morphology to those of *C. peroni* Laporte & Gory (Fig. 2) but are somewhat larger. The two species can be distinguished on other morphological features (e.g. elytral spots and apical abdominal sternites, see Key to Species above). Despite being superficially alike on gross facies, the Australian species of *Chrysobothris* can be generally determined and distinguished on the size and shape of the male genitalia (e.g. see Fig. 2). *C. saundersi* has often been confused with *C. subsimilis* in museum collections, but again, these species can be separated clearly on the basis of the male genitalia. Although the male genitalia of these two species are similar in size (Figs 2d and 2e), the penis of *C. subsimilis* is wider and the membranous lobes on the parameres each have an additional smaller accessory lobe (Fig. 2d).

Distribution

The majority of the specimens of *C. saundersi* in the Australian collections have been collected from the central-east and south-east of Queensland (Fig. 4). These areas are largely dominated by *Acacia* scrublands and open *Eucalyptus-Callitris* woodlands, but a lot of the original vegetation has been cleared since the Second World War for agriculture. The specimens recorded from Beltana near the northern end of the Flinders Range of South Australia (30°48'S, 138°25'E), Harts Range of the Northern Territory (23°00'S, 134°56'E) and Coolgardie, Western Australia (30°57'S, 121°10'E)(Fig. 4) are surprising since there are no collections from the intervening areas which are very widely separated. These specimens may have been mislabelled or possibly the species has been poorly collected in these three States. However, the recent collection of *C. saundersi* from near Hill End, New South Wales, is the first record for this State and is also a considerable distance from the main sites of collection of this species

in south-eastern Queensland. Perhaps these represent outlying, remnant populations of *C. saundersi*, a species which may have contracted in range over time, as a result of changing environmental conditions and/or competition with other insects. For instance, a related species,*Chrysobothris saundersi* Thomson, is widely distributed across the continent and it is possible that this species may have outcompeted *C. saundersi* during some stage throughout much of the latter species former range. However, this suggestion is hypothetical and the status and ecology of *C. saundersi* in these and intervening areas of South Australia, Northern Territory, New South Wales and Western Australia awaits further intensive field work.

Larval host plant

The larval host plants and general biology of the Australian *Chrysobothris* species are poorly known. Hawkeswood & Peterson (1982) and Hawkeswood (1986a) noted that the larvae of *C. queenslandica* Hawkeswood develop in the dead wood (trunk and branches) of still-standing *Acacia bidwillii* Benth. (Mimosaceae) in grassy wood-lands of north-eastern Queensland. Williams (1985) recorded *Rapanea variabilis* (R.Br.) Mez (Myrsinaceae) as a larval host for *C. viridis* Macleay (cited as *C. simplicifrons* Kerremans) in littoral rainforest in central coastal New South Wales. Hawkeswood (1988) recorded *A. peuce* F. Muell. (Mimosaceae) as a host for *C. subsimilis* Thomson in arid central Australia. The only previously published larval host record for *C. saundersi* Macleay is that of Hawkeswood (1986b) who recorded *A. leiocalyx* (Domin) Pedley (Mimosaceae) from semi-arid southern Queensland. Our new record of *Casuarina stricta* Dryander is therefore the first to record this plant genus as a host for a *Chrysobothris*. The only other Australian buprestids known to breed in this species of *Casuarina* are *Temognatha fortnumi* (Saunders) (Tepper 1887; as *Stigmodera fortnumi*) and *T. suturalis* (Donovan) (French 1909; as *Stigmodera suturalis*). Other Australian buprestids are known to breed in other *Casuarina* species (Hawkeswood & Peterson 1982, Hawkeswood & Turner, unpub. data). Overall, the preferred larval host plants of the Australian *Chrysobothris* (at least the arid and semi-arid adapted species) appear to be *Acacia*, but occasionally, as in the case of *C. saundersi*, *Casuarina* and possibly other plants, act as secondary host plants for the larvae. Further research in the Turondale-Hill End area may reveal *Acacia* as a primary host for *C. saundersi* as well.

Sexual differences in larval galleries and exit holes

Recently, the careful observations of JRT have revealed interspecific (inter-generic) differences in larval galleries, pupal chambers and/or exit holes and in some cases, marked intraspecific sexual differences in these features. For instance, in *Astraeus crassus* Van De Poll (Turner & Hawkeswood 1996b), the exit holes of the male beetle are usually positioned at 0° to the latitudinal axis of the host branch and measure mostly 6 mm × 5 mm, while those of the females are positioned about 45° to the latitudinal axis and are larger, measuring 8 mm × 6 mm. *Chrysobothris saundersi* from New South Wales appears to have markedly sexual dimophic larval galleries, pupal chambers and exit holes (Figs 3a-f). Whether these occur in other populations of the species remains to be determined.

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